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Research Note

Intestinal Helminths in Mourning Doves (*Zenaida macroura*) from Arizona, Pennsylvania, South Carolina, and Tennessee, U.S.A.

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ABSTRACT: We examined 115 hunter-killed mourning doves (*Zenaida macroura*) from 4 states (Arizona, Pennsylvania, South Carolina, and Tennessee, U.S.A.) in 1998 and 1999 to investigate geographical variation in the prevalence and intensity of intestinal helminth infections. Four intestinal helminth species were identified: *Killigrewia delafondi*, *Ornithostrongylus crami*, *Ascaridia columbae*, and *Capillaria obsignata*. The number of worms (all helminth species combined) per infected bird ranged from 1 to 166 (mean ± SE = 12.7 ± 7.45, median = 2.0). Filarids, *Aproctella stoddardi*, were found in 2 birds but were probably adhering to the outside of the intestine. Overall, 18% of the doves were infected with 1 or more species of helminths. The percentage of doves infected with at least 1 helminth species varied from 4% in Arizona to 27% in South Carolina. Mixed infections occurred in only 3 individuals (14% of infected birds). We found no significant differences in prevalence of infection among any of the 4 helminths by host age or sex, and prevalences were too low to test for differences among states. The intensity of *O. crami* was higher in males than in females but did not differ significantly among states. Intensities of the other 3 helminths did not differ by sex or state, and we found no differences in helminth intensity by age. Intestinal length was significantly greater in infected than in uninfected birds.

KEY WORDS: Helminths, mourning dove, *Zenaida macroura*, *Killigrewia delafondi*, *Ornithostrongylus crami*, *Ascaridia columbae*, *Capillaria obsignata*, Arizona, Pennsylvania, South Carolina, Tennessee.

Previous studies of mourning dove (*Zenaida macroura*) helminths in the United States have been limited to the southeastern states (e.g., Barrows and Hayes, 1977; Conti and Forrester, 1981; Forrester et al., 1983), except for a study in Illinois in which no intestinal parasites were found (Hanson et al., 1957). Geographic patterns in the distribution of helminths within specific hosts have been evaluated often (Bush, 1990), but we are unaware of reports addressing geographic patterns in the distribution of helminth communities of mourning doves outside the southeastern United States. Because macroparasites are capable of regulating host populations (Dobson and Hudson, 1992), information on the geographic variation in helminth infections in mourning doves may aid in understanding dove population dynamics. In addition, information on the range and variation in abundance of helminth species might provide further insight into the ecology of these parasites. In the present study our objectives were to identify the helminth fauna in a sample of mourning doves and to determine whether the prevalence and intensity of helminths varied according to geographic location or the age or sex of the host.

We examined 115 hunter-killed mourning doves that were shot during the first 2 wk of September in 1998 and 1999 at 3 locations in Arizona, U.S.A. (33°19′N 112°38′W; 32°44′N 111°29′W; and 32°36′N 111°34′W); 6 locations in Pennsylvania, U.S.A. (40°07′N 77°27′W; 40°26′N 75°11′W; 40°02′N 76°15′W; 40°22′N 76°28′W; 40°45′N 75°18′ W; and 40°37′N 75°35′W); 2 locations in South Carolina, U.S.A. (34°39′N 79°41′W and 33°21′N 80°16′W), and 2 locations in Tennessee, U.S.A. (36°11′N, 86°32′W and 36°01′N, 86°31′W). Because sample sizes from each site within a state were small, samples from each state were pooled. The number of carcasses examined from each of the states were Arizona, 23; Pennsylvania, 31; South Carolina, 30; and Tennessee, 31. Age was determined by plumage characteristics (Mirarchi, 1993), and sex was determined by visual examination of gonads. For each carcass the intestine from the point of attachment to the gizzard to the cloaca was removed and kept

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frozen (−20°C) until it was examined for helminths. Intestine length was measured (±0.5 cm) using a ruler on a flat surface. Intestinal contents were washed out with water into a petri dish, and any contents adhering to the mucosal surface were removed by scraping with a pair of forceps. Intestinal contents from each individual were examined for parasites using a dissecting microscope at ×10 magnification. Helminths were fixed in 70% ethanol. Nematodes were studied in temporary mounts of lactophenol, and cestodes were stained with Ehrlich's hematoxylin and mounted in Canada balsam. Representative specimens of the helminths found in this study have been deposited at Harold W. Manter Laboratory of Parasitology, University of Nebraska, Lincoln, Nebraska, U.S.A.: accession numbers 16593 (*Aproctella stoddardi*), 16594 (*Ascaridia columbae*), 16595 (*Capillaria obsignata*), 16596 (*Ornithostrongylus crami*), and 16599 (*Killigrewia delafondi*). Livers of mourning doves were analyzed for lead concentration by atomic absorption spectrometry (Ihnat, 1999) for a separate study.

The parameters prevalence, intensity of infection, and mean intensity were used according to Bush et al. (1997). Using chi-square tests we compared the percentage of doves infected with at least 1 species of helminth among states and the prevalences of helminth species between males and females and between juveniles and adults. The intensities of helminth infections for individual doves were compared using Kruskal-Wallis *H*-test or Mann–Whitney *U*-test. We used Spearman rank correlation to compare helminth intensity with liver lead concentration. The intestinal lengths of infected and uninfected birds were compared using a *t*-test for 2 independent samples. Statistical analyses were performed in SPSS® for Windows v.10.0 (SPSS, 1999) or SAS® (SAS Institute, 1996), $\alpha = 0.05$.

Four species of intestinal helminths were found: 3 nematodes (*A. columbae*, *C. obsignata*, and *O. crami*) and 1 cestode (*K. delafondi*). These species have been reported previously in mourning doves. *Ornithostrongylus crami* (formerly lumped with *Ornithostrongylus quadriradiatus* but now considered a separate species by Durette-Desset et al. [2000]) has been found in mourning doves throughout the southeastern United States (Barrows and Hayes, 1977; Conti and Forrester, 1981; Forrester et al., 1983). In addition to South Carolina and Tennessee, we also found *O. crami* in mourning doves from Pennsylvania. *Ascaridia columbae* has been reported in mourning doves from Florida and South Carolina (Barrows and Hayes, 1977); our results extend its known range in mourning doves to include Tennessee and Pennsylvania. We found *C. obsignata* in 1 adult male dove from South Carolina; this nematode has been reported previously at a low prevalence in mourning doves collected in Florida (Forrester et al., 1983). Four mourning doves, 1 from Arizona and 3 from South Carolina, were infected with the cestode *K. delafondi*, which has also been found in mourning doves in the southeastern United States (Forrester et al., 1983). In addition, a filarial worm, *A. stoddardi*, was found in a juvenile male dove and an adult female dove from South Carolina. This nematode usually resides in the abdominal cavity (Conti, 1993) and may have been adhering to the exterior wall of the intestinal tract or the mesenteries.

The diversity of intestinal helminths (4 species) that we found in mourning doves collected in September in 4 states is lower than that reported in other studies, except for Hanson et al. (1957), who found no intestinal helminths in mourning doves sampled in Illinois. Excluding helminths normally found in the proventriculus and the body cavity, Barrows and Hayes (1977) found 5 species of intestinal helminths in mourning doves collected in 12 southeastern states, and in 2 studies in Florida, Forrester et al. (1983) found 10 species, and Conti and Forrester (1981) found 7 species of intestinal helminths. Barrows and Hayes (1977) and Forrester et al. (1983) sampled doves throughout the year, and Conti and Forrester (1981) collected doves in July and August. Seasonal variation in prevalence of avian helminth infections has been found in several studies (reviewed in Bush, 1990), including Forrester et al.'s (1983) survey of mourning dove parasites in Florida, where *Ornithostrongylus* spp. prevalence and intensity were highest in spring and summer, and *A. columbae* prevalence was highest in winter. Seasonal differences in collection periods and the fact that two of the earlier studies involved year-round collections may explain why we found a lower diversity of intestinal helminths.

Overall, 18.3% of the mourning doves examined were infected with at least 1 species of intestinal helminth. The percentage of doves infected with at least 1 intestinal helminth species was 4.35 in Arizona, 12.9 in Pennsylvania, 26.7 in South Carolina, and 25.8 in Tennessee, but it did not differ significantly among states ($\chi^2 = 7.210$, df = 3, $P = 0.065$). These percentages are low compared with the results of other studies: more than 80% of the doves examined were infected with at least 1 species of helminth in 2 studies of mourning doves from Florida (Conti and Forrester, 1981; Forrester et al., 1983), and more than 50% of the mourning

doves examined from the southeastern United States were infected with helminths (Barrows and Hayes, 1977). *Ornithostrongylus* spp. were the most prevalent species in all 3 of these studies, and Forrester et al. (1983) found *Ornithostrongylus* spp. prevalence to peak in the spring and summer months, a time period not included in our sample. Thus, the relatively low observed helminth prevalence may in part be a seasonal effect. However, geographical sampling region may also account for the difference: the above studies examined doves collected in Florida, where high rainfall and mild winters create favorable conditions for many helminth eggs and larval stages. *Ornithostrongylus crami*, one of the most prevalent species found in this study, has eggs that cannot tolerate freezing and larvae that have low tolerance for desiccation (Cuvillier, 1937).

Mixed infections were rare: *O. crami* and *A. columbae* were found together in 3 doves from Tennessee. Prevalence and mean intensity of each helminth species by state are shown in Table 1. The most prevalent helminth was *A. columbae* in mourning doves from Tennessee (25.8%), but it was represented by only 1 specimen each in Pennsylvania and South Carolina and was absent in doves from Arizona. *Ornithostrongylus crami* was found at approximately 10% prevalence in all the states sampled except Arizona, where it was absent; *K. delafondi* was found only in low prevalence in Arizona (4.35%) and South Carolina (10.0%); *C. obsignata* was detected in only 1 dove, an adult male from South Carolina. Prevalences of *A. columbae* did not vary significantly with dove age or sex class ($\chi^2 = 2.335$, df = 1, $P = 0.126$ and $\chi^2 = 1.677$, df = 1, $P = 0.195$); low prevalences of individual helminth species precluded additional statistical analyses of associations between host characteristics or state and helminth species prevalences.

Combining all 4 species of helminths, the number of worms per infected dove in our study ranged from 1 to 166 (mean = 12.7), almost identical to the range (1–163) and similar to the mean (14.0) reported for mourning doves in Florida by Forrester et al. (1983), who sampled doves throughout the year. In another study in Florida, the total number of intestinal helminths in mourning doves collected in July and August at 2 locations ranged from 1 to 27 and from 1 to 87 (means = 6.6 and 19.9), respectively (Conti and Forrester, 1981). Helminth intensity was not correlated with the concentration of lead in the liver ($n = 18$, $r = -0.329$, $P = 0.182$). Intensities of *A. columbae* and *O. crami* did not differ between adult and juvenile doves ($U = 8.0$, $P = 0.566$ and $U = 10.0$, $P = 1.0$). In contrast, Forrester et al. (1983) found a significantly higher intensity of *A. columbae* in adult than in juvenile doves. Their year-round sampling study may have sampled much younger (and thus not yet exposed) birds not represented in our study. The intensities of *A. columbae* and *O. crami* did not differ significantly between sexes ($U = 7.50$, $P = 0.491$ for *A. columbae*; $U = 1.0$, $P = 0.054$ for *O. crami*) or among states ($H = 2.54$, $P = 0.281$ for *A. columbae*; $H = 5.78$, $P = 0.056$ for *O. crami*).

Mean intestinal length was significantly greater in infected than in uninfected birds (means ± SE = 58.4 ± 1.69 cm vs. 53.0 ± 0.07 cm, $T_{112} = 3.272$, $P = 0.001$). Helminth infection has been shown to alter intestinal morphology in mammals (e.g., Coop and Angus, 1975; Dwinell et al., 1998) and domestic birds (Crompton and Nesheim, 1976). In chickens (*Gallus gallus*), nematode infections have been found to be associated with epithelial desquamation and distension of the lumen (reviewed in Crompton and Nesheim [1976]). In addition, Simberloff and Moore (1997) found that the number of helminth species in Northern bobwhites (*Colinus virginianus*) was positively correlated with intestinal length. Intestinal parasites can cause loss of digestive function (reviewed in Crompton and Nesheim [1976]), and an increase in the size of the intestine may be a compensatory measure.

Mourning dove populations in different U.S. management units are largely independent of each other (Tomlinson, 1993). We believe that the data presented herein reflect accurately the helminth fauna in mourning doves in the eastern and western management units. However, our sample of mourning doves was not completely representative of the population because it included only those birds capable of flight, excluding moribund and prefledging birds. Samples in most mourning dove helminth studies include both shot and live-trapped birds. Our data are generally comparable with these studies because a sample of live-trapped doves also excludes prefledging birds and most moribund birds.

Overall, the helminth parasite species richness and prevalences that we found were lower than in some previous studies, in part because our sample did not include the proventriculus and the kidney, from which 3 additional helminth species have been reported in mourning doves (Conti and Forrester, 1981; Forrester et al., 1983). However, mean total helminth intensity was comparable with previously reported means. As with the studies of Barrows and Hayes (1977), Conti and Forrester (1981), and

Table 1. Percent prevalence (No. of infected/*n*) and mean intensity (±SE, range) of infection for 4 species of intestinal helminths infecting mourning doves (*Zenaida macroura*) from Arizona, Pennsylvania, South Carolina, and Tennessee, U.S.A.

	Ascaridia columbae		*Capillaria obsignata*		*Ornithostrongylus crami*		*Killegrewia delfondi*	
State	Percent prevalence (No. of infected/*n*)	Mean intensity (±SE, range)	Percent prevalence (No. of infected/*n*)	Mean intensity (±SE, range)	Percent prevalence (No. of infected/*n*)	Mean intensity (±SE, range)	Percent prevalence (No. of infected/*n*)	Mean intensity (±SE, range)
Arizona	0 (0/23)		0 (0/23)		0 (0/23)		4.3 (1/23)	2 (±0)
Pennsylvania	3.2 (1/31)	12 (±0)	0 (0/31)		9.7 (3/31)	1.33 (±0.33, 1–2)	0 (0/31)	
South Carolina	3.3 (1/30)	14 (±0)	3.3 (1/30)	1.0 (±0, 1)	10.0 (3/30)	1.0 ± 0 (1)	10.0 (3/30)	1.67 (±0.67, 1–3)
Tennessee	25.8 (8/31)	24.1 (±20.3, 1–166)	0 (0/31)		9.7 (3/31)	15.0 (±6.08, 4–25)	0 (0/31)	

Forrester et al. (1983), the parasite fauna is dominated by species with direct life cycles (e.g. *A. columbae, Ornithostrongylus* spp., *C. obsignata*) (Anderson, 2000). Low prevalence of species with indirect life cycles may be related to the primarily herbivorous food habits of mourning doves (Armstrong and Noakes, 1981) and may explain the comparatively low species richness in this host. The prevalence of cestode species with indirect life cycles (e.g., *K. delafondi* and *Raillietina* spp.) has not been reported to exceed 5%.

The data presented herein extend the geographic distribution of *K. delafondi*, *O. crami*, *A. columbae*, and *C. obsignata* in mourning doves. Further studies characterizing mourning dove helminth communities combined with studies of their effects on host survival and fecundity may help in understanding better what, if any, influence helminths have on the dynamics of mourning dove populations.

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